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QUARTERLY PROGRESS REPORT

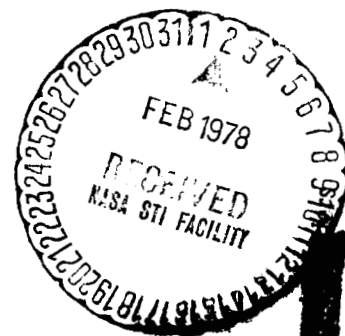
JULY

AUGUST

SEPTEMBER

1965

Bellcomm, Inc.



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Report No. 65-101-4
Contract NASw-417
October 29, 1965

BELLCOMM, INC.
QUARTERLY PROGRESS REPORT
July, August, September
1965

J. A. Hornbeck
President

BELLCOMM, INC.
Washington, D. C.

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QUARTERLY PROGRESS REPORT

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BELLCOMM, INC.

Report No. 65-101-4
Contract NASw-417

ABSTRACT

The activities of Bellcomm, Inc., during the quarter ending September 30, 1965 are summarized. Reference is made to reports and memoranda issued during this period covering particular technical studies.

BELLCOMM, INC.

BELLCOMM, INC.
QUARTERLY PROGRESS REPORT
July, August, September
1965

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BELLCOMM, INC.

GENERAL STUDIES

BELLCOMM PERFORMS STUDIES, TECHNICAL FACT FINDING AND EVALUATION, ANALYTICAL INVESTIGATIONS, CONSULTING EFFORT AND RELATED PROFESSIONAL ACTIVITIES IN SUPPORT OF MANNED SPACE FLIGHT AND RELATED PROGRAMS OF NASA. THESE ARE CARRIED OUT AT BELLCOMM'S INITIATIVE OR MAY BE PRELIMINARY TO ISSUANCE OF SPECIAL TASK ORDERS.

- A. Various trajectory programs have been formulated which deal with transfer from earth launch or from arbitrary earth parking orbits to inter-planetary trajectories. The programs have been used to compute trajectory data for Venus swingby missions during the 1978 to 1983 time periods.
- B. Trade off studies are being conducted to compare nuclear propulsion with chemical vehicle requirements for manned Mars stopover missions. These studies include determination of the optimum thrust-to-weight ratios for solid core nuclear stages for earth escape, Mars capture and Mars escape.
- C. Performance studies^{(1) (2)} for uprating the Saturn IB have been conducted. These studies include such things as stage "zero" configuration (solid strap-on motors) and modifications of the H-1 Engine for altitude performance. Trajectories for the Saturn IB/Centaur-Voyager configuration were run to determine payload capability for missions of various energy requirements for both sub-orbital and orbital starts of the Centaur stage.
- D. A countdown has been examined as a stochastic process and the probability density function for the total countdown duration has been derived. The model is general.⁽³⁾
- E. Reviews of Experiments S-21, S-23, D-17, MSF-1, MSFC 1, 2, 3, 4, 5, 7, 8, 9, S 1001, S 1002, and S 1003 have been provided to the Manned Space Flight Experiments Board.
- F. Considerations for improving flexibility in the countdown for the Apollo/Saturn V lunar landing mission were published.⁽⁴⁾

(1) Payload Capabilities of Saturn-IB Launch Vehicles with Boost Assisting UTC Solid Rocket Motors, Memorandum for File, D. R. Valley, July 7, 1965.

(2) Modification of the H-1 Engine for Altitude Performance with the Saturn-IB/Stage "O" Vehicle, Memorandum for File, D. R. Valley, July 26, 1965.

(3) The Analysis of a Countdown as a Stochastic Sequential Process with Recycle Policies, TM-65-1031-2, J. S. Engel, August 16, 1965.

(4) Proposed Improvement in Countdown Flexibility for the Apollo/Saturn V Lunar Landing Mission, Memorandum for File, C. H. Eley, September 30, 1965.

- G. A brief review was completed of the impact on SM and LEM structure of an increase in RCS engine inert weight. (5)
- H. A study of the fuel cell performance on the GT-5 mission was completed which indicated that the problems experienced on GT-5 would have no significant impact on the Apollo program. (6)
- I. An analysis of the effects of failure in the LEM Reaction Control System was completed and documented. (7)
- J. A study of the feasibility of changing RCS mixture ratios and propellants (8) was completed with the conclusion that changes were possible but with major impact on the LEM RCS main propellant interconnect system and on the qualification of the RCS thruster.
- K. Several reported problems associated with the use of Teflon insulated wire in space vehicles were reviewed. A summary of available information and the conclusions and recommendations resulting from analysis of the data were furnished to NASA. (9)

(5) Response to Action Item "What are the Effects on LEM and SM Structure of Increasing RCS Engine Weight." Memorandum for File, J. J. O'Connor and V. Muller, August 27, 1965.

(6) Report on Excess Water Production of Fuel Cells on GT-5, Memorandum for File, F. N. Schmidt, September 30, 1965.

(7) An Analysis of Failure Effects on the Lunar Excursion Module Reaction Control System, Memorandum for File, R. R. Schreib, September 13, 1965.

(8) RCS Mixture Ratio and Propellant Changes (U) Memorandum for File, G. R. Huson, July 30, 1965, CONFIDENTIAL.

(9) Memorandum to M. Savage - NASA/MAT from J. Z. Menard - Teflon Insulated Wire for Space Vehicle. August 17, 1965.

SPECIAL TASK STUDIES

The following is a summary of the status of effort either under way or completed during this quarter on Bellcomm's Special Task Orders under Contract NASw-417.

TASK ORDER NO. 1

ASSIST MSF IN THE PREPARATION OF DOCUMENTS DEFINING THE APOLLO MISSION AND SPECIFYING SYSTEM CHARACTERISTICS.

During the quarter, draft appendices to the Apollo Program Specification for Apollo Saturn Missions 202, 203, 204, 205, 501, and 502 were delivered to the Apollo Program Office Configuration Control Board. These appendices were approved by the CCB. Work is continuing on appendices for missions AS-206, 207, 503, 504, and 505.

Comments on the Apollo Program Specification by MSC were reviewed. As a result of this review, 33 specification change notices were prepared and submitted to the Configuration Control Board for approval. Work is continuing on the evaluation of the remainder of the MSC requests for changes to the specification.

Section 9-Technical Description and Systems Engineering, and Section 16-Related Programs of the Apollo Program Development Plan were reviewed and revised to reflect current program plans.

Available inter-Center interface control documents for AS-201 and AS-501 were reviewed⁽¹⁰⁾ for compliance with proposed ICD criteria which define required ICD coverage in the hardware and software areas. The criteria used agreed substantially with criteria subsequently adopted by the Panel Review Board.

(10) Review of AS-201 and AS-501 Inter-Center Interface Control Documents, Memorandum for File, W. T. Botner, J. D. Richey, C. M. Volk, H. A. Wente, August 30, 1965.

TASK ORDER NO. 9

APOLLO TRAJECTORY ANALYSIS AND COORDINATION

Work continued throughout the quarter on a study of lunar accessibility with the free-return restriction removed. The emphasis is primarily on variation of accessibility over long periods of time.

The guidance and navigation error analysis for the complete lunar landing mission is nearing completion. The numerical results of TRW Systems' effort and their final report have been delivered and are under review.

Work continues on guidance computer software validation through participation on the MSC Guidance Software Control Panel and through informal reviews of guidance equations for missions AS-202 and AS-204. A report was prepared outlining some of the important elements of a validation plan. (11)

Evaluation of LEM digital autopilot techniques continued with active participation in the LEM guidance and control implementation meetings and through discussions with MSC and MIT/IL.

A study of the development history and state of the art of optical trackers was completed, and the results were informally reported to MSC. Participation continued in design reviews of the LEM optical tracker.

The concentric rendezvous mode of LEM ascent was reviewed for compatibility with various aspects of the hardware and constraints of the lunar landing mission.

Work is continuing to assist MSC in their evaluation of the IBM backup computer. An oral report was given as part of a review of the IBM development held at MSC on September 28, 1965.

(11) A Plan for Validation and Verification of Apollo Computer Software, TR 65-209-6, J. S. Engel, W. G. Heffron, July 1, 1965.

TASK ORDER NO. 11

TO CARRY OUT STUDIES LEADING TO THE EVALUATION OF THE NATURAL ENVIRONMENTAL FACTORS, AND ASSOCIATED EXPERIMENTAL PROGRAMS, IMPORTANT TO THE SUCCESSFUL PERFORMANCE OF THE MANNED SPACE FLIGHT PROGRAM.

Surveyor Program

Various experiments were considered for the Surveyor spacecraft and recommendations were made concerning the inclusion of a critical data recorder and a rocket erosion experiment. Further effort was made to define a Surveyor-carried visual landing aid for Apollo.

An analysis was made of the capability of the Surveyor TV cameras to take pictures by earthlight⁽¹²⁾.

Studies were made of potential landing sites for Surveyor A considering both terrain classification and system constraints. Computer studies were initiated to determine those areas of the lunar surface which are accessible to Surveyor. A recently completed patched conic trajectory program is now being applied to the calculation of vertical impact points for use in Surveyor mission planning.

Lunar Orbiter Program

Effort was directed toward the definition of a distributed mission for the first Lunar Orbiter flight. Studies were performed concerning the criteria for target selection, trajectory implications and spacecraft and camera system constraints. These studies were carried out in cooperation with the Lunar Orbiter Program and Project Offices.

The study initiated during the last quarter on the off-nominal mission alternatives for the Lunar Orbiter was completed.⁽¹³⁾ It was concluded that the usefulness of the Lunar Orbiter missions to the Apollo program could be increased by consideration of these alternatives.

Lunar Surface Data Analysis

A study was completed to define the analysis of earth-based and unmanned program data on the lunar surface. These data are required to meet the needs of Apollo for site selection, training and operations.⁽¹⁴⁾ Study of the analysis required of

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- (12) Surveyor TV Pictures by Earthlight, Memorandum for File, H. W. Radin, July 29, 1965.
- (13) Off-Nominal Mission Possibilities for Lunar Orbiter, TM-65-1012-8, F. N. Schmidt, September 15, 1965.
- (14) Apollo Lunar Data Analysis, TM-65-1012-7, C. J. Byrne, July 19, 1965.

the Lunar Orbiter data indicated the need for camera calibration⁽¹⁵⁾ and tape recording of telemetered signals⁽¹⁶⁾. A memorandum describing a procedure for reducing the time required for the digital processing of photographs has been issued⁽¹⁷⁾.

Data obtained from earth-based observations of the moon have been collected, including photography in the visible region of the spectrum, infrared emission, radar reflections and geologic and cartographic interpretations. The various data formats have been photographically converted to a common scale to facilitate comparison. These data will be examined to determine the existence of correlations.

Environmental Studies

A draft of "Requirements for Environmental Data in Support of the Apollo Program" (U) Issue IV, (Confidential) incorporating comments received on the earlier draft has been delivered to the Apollo Program Office.

The radiation sensitivity of LEM components has been examined and a study of the radioactive sources associated with the Apollo spacecraft has been initiated.

A study of the Apollo meteoroid environment has been completed and a report has been issued. (18)

The kinematics of the dust cloud reportedly observed at the time of the impact of the Luna 5 spacecraft have been examined. The results indicate the feasibility of such cloud formation but do not allow any conclusion to be drawn concerning the state of the lunar surface. (19)

A study has been initiated to review current descriptions of the lunar environment. This study will include consideration of the results of Ranger missions and recent earth-based observations. A continuing effort was maintained on lunar soil mechanics with particular emphasis on measurement techniques and rocket exhaust plume erosion.

(15) Lunar Orbiter Data Analysis-Data Accuracy Goals, TM-65-1012-5, C. J. Byrne, July 2, 1965

(16) Tape Recording of Lunar Orbiter Pictures, TM-65-1012-6, C. J. Byrne, July 6, 1965

(17) A Procedure for Reducing the Time Required for the Digital Processing of Photographs, TM-65-1012-4, M. A. Leibowitz, August 25, 1965

(18) The Meteoroid Environment of the Apollo Program, TR-65-211-5, J. S. Dohnanyi, August 30, 1965.

(19) Dust Cloud Produced by Luna-5 Impacting the Lunar Surface, Memorandum for File, J. S. Dohnanyi, August 3, 1965.

Apollo Experiments Program

Effort was directed towards the documentation of the Apollo Experiments Program including:

The preparation of a draft of Section 18 --

Experiments of the Apollo Program Development Plan.

TASK ORDER NO. 12

ASSISTANCE IN CERTAIN COMPUTER OPERATIONS AND RELATED ACTIVITIES

During the period July 1, 1965 through September 30, 1965, NASA usage of the 7044 computer was 10.50 hours. Independent NASA usage (non-BCMSYS) for the 7040 was 0.71 hours.

During the same period Bellcomm usage of the 7044 computer was 759.56 hours. Independent Bellcomm usage (non-BCMSYS) for the 7040 was 8.76 hours.

Total usage of the 7040 was 943.90 hours.

TASK ORDER NO. 14

MISSION OPERATIONS ANALYSIS

The draft Apollo Mission Sequence Plan was completed during this quarter and is in final review. Associated studies are being continued to refine the mission sequence.

Work has continued in support of the Mission Operations directorate in the definition of mission **rules**.

TASK ORDER NO. 15

FORMULATION OF SYSTEM REQUIREMENTS FOR AND EVALUATION OF COMMUNICATION FACILITIES TO BE USED FOR APOLLO FLIGHT MISSIONS.

During the quarter a report was prepared and distributed summarizing the work performed under Task 15, Amendment 1 covering the period from April 1, 1964 through March 31, 1965. (20)

The coverage provided by the Unified S-Band stations in the Apollo MSFN was calculated for launch azimuths of 72°, 80°, 90°, 100°, and 108° for eighteen revolutions at an altitude of 105 NM. The results are given in charts which show how the coverage varies with launch azimuth to assist in planning Apollo test missions. (21)

The effect on coverage of the orientation of the axes of the antennas at the Apollo MSFN sites with their resulting gimbal lock restrictions was investigated. In particular, the 85 ft antenna stations of the Apollo MSFN at Goldstone, Canberra and Madrid use an East-West orientation of the gimbal lock region. This constraint was evaluated to determine whether the reduction in communication coverage was significant. It was found that the loss in coverage would be compensated for by coverage from other stations. (22)

The potential use of communication satellites in the Apollo system continued as a subject of active investigation. The possibility of direct relay of all data from the spacecraft to the control center over satellites was reviewed orally for MSF and OTDA in June and further detailed feasibility studies were recommended. (23) The choice of frequency (VHF or S-band) for the link between a space vehicle and a communications satellite was reviewed. It was found that S-band operation would be markedly superior. (24)

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- (20) Summary of Work Performed Under Bellcomm/NASA Task 15 Amendment 1 (April 1, 1964 - March 31, 1965), TR-65-215-2, J. J. Hibbert, A. G. Weygand, July 30, 1965.
- (21) Unified S-Band Tracking and Communications Coverage of the Manned Space Flight Network During Eighteen Earth Revolutions at 105 NM Altitude for Launch Azimuth at 72, 80, 90, 100, and 108 Degrees, Memorandum for File, J. P. Maloy, July 9, 1965.
- (22) The Effects of Ground Antenna Gimbal-Lock on Communications Coverage at the 85 Foot Antenna Apollo MSFN Stations, Memorandum for File, H. Pinckernell, September 16, 1965.
- (23) Presentation on "Communicating Total Data from Space Vehicles to MCC in Real Time", Memorandum for File, J. J. Hibbert, July 27, 1965.
- (24) Choice of Frequency for Direct Relay Link Between Space Vehicles and Communication Satellites for Relay to MCC-H, Memorandum for File, E. M. Coombs, August 5, 1965.

A summary report describing the electromagnetic interference control activities of the NASA Centers for the Apollo Program was prepared and distributed. (25)

The design of optimum modulation indices for phase modulated frequency multiplexed communication systems such as the Apollo Unified S-Band system has been investigated and a method of obtaining such a design is described. (26)

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- (25) Summary of the Electromagnetic Interference Control Activities of the MSFC, the KSC, and the MSC for the Apollo Program, TM-65-2021-7, A. G. Weygand, August 9, 1965.
- (26) Optimization of Modulation Indices in Phase Modulated Frequency Multiplexed Communication Systems, TM-65-2021-6, J. D. Hill, August 3, 1965.

TASK ORDER NO. 17

APOLLO FLIGHT MISSION ASSIGNMENTS

In preparation for reissue of the Apollo Flight Mission Assignments document, additional primary objectives and configuration data were established to complete entries for all assigned Apollo Saturn IB missions and for Apollo Saturn V missions through AS-503. Payload and flight profile information was updated in cooperation with inter-Center working groups.

Work continued on assessment of capabilities for real-time alternate missions in the Apollo flight test program. A review of the real-time alternates to be implemented is being planned for the next Panel Review Board.

Data has been prepared for the initial issue of a periodic report presenting current weight and performance data for Apollo space vehicles. This report is expected to include launch vehicle payload margins, spacecraft inert weights, and engine performance.

TASK ORDER NO. 18

PLANNING OF SYSTEMS OPERATIONS AND EXPLORATION TASKS - FIRST PHASE
MANNED LUNAR EXPLORATION

Studies of Apollo Applications (AAP) missions in earth orbit, lunar orbit, and on the lunar surface are continuing.

Attention has been directed to the areas of Apollo Applications experiments, scheduling, ground rules, and hardware allocations. A draft of "Apollo Extension Systems (AES) Capabilities for Earth Orbital and Lunar Experiments" was prepared.

A summary of the experiments under consideration for the AAP was delivered. Several tentative allocations of experiments to two proposed modification centers were prepared.

A draft of the revised "Flight Mission Assignment Plan" for the AAP has been prepared to incorporate the latest MSF hardware allocations. Tentative experiment assignments for study purpose have been made for four of the early flights.

Trajectory studies for AAP missions are continuing. In particular, problems related to alternate orbital transfer modes for attaining earth synchronous orbits are being considered. Work is in progress in communications coverage and the handling of experiment data of AAP missions.

A study of an operational program leading to continuous earth orbital missions has been concluded. (27) A preliminary feasibility was established for five modes using Apollo Saturn systems.

(27) Apollo Extension Systems for Continuous Earth Orbital Missions (U), TM-65-1013-2, P. W. Conrad, August 18, 1965 CONFIDENTIAL.

TASK ORDER NO. 19

MISSION CONTROL CENTER ACCEPTANCE

A final technical report on Task Order No. 19 was submitted.⁽²⁸⁾ This report covered the effort on systems studies, overall acceptance planning review, Phase IV and V test review, and special studies. The special studies included work on the communications processor, display readability and MCC equipment utilization.

(28) Mission Control Center - Houston; Acceptance Plan Review: Final Technical Report, TR 65-219-1, July 30, 1965, L. A. Ferrara

TASK ORDER NO. 20

LUNAR LANDING SYSTEMS ENGINEERING STUDY

Work on this task was completed during this quarter; A review of this effort was presented by Bellcomm and its subcontractor, Bendix Corporation, at MSC on September 15, 1965.

The final report⁽²⁹⁾ summarizes and discusses work accomplished under the second phase of the task. This report includes a review of experimental and analytical subcontracted effort, discussions of landing system performance, consideration of various means of improving LEM landing capability, and a review of the environmental and functional specifications.

Ten memoranda^(30 through 39) covering astronaut control during lunar landing, vehicle-soil interaction mechanisms, effects of descent engine skirt on landing, effects of initial touchdown conditions on LEM landing capability, and a review of subcontractor developed computer programs have been published during this quarter.

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- (29) Final Report Task 20 Amendment 1, TR-65-220-3, D. Macchia, J. M. Tschirgi, September 8, 1965.
 - (30) Astronaut Control of the Lunar Landing, Memorandum for File, August 27, 1965, S. J. Schoen.
 - (31) Soil Effects on Lunar Landing Dynamics, Memorandum for File, J. A. Nutant, September 3, 1965.
 - (32) Vehicle Footpad Shape Effects on Soil Landings, Memorandum for File, J. A. Nutant, September 3, 1965.
 - (33) The Effects of Descent Engine Nozzle Side Loads on LEM Landing Stability, Memorandum for File, D. Macchia, September 3, 1965.
 - (34) LEM Descent Engine Jettisonable Skirt, Memorandum for File, J. Wong, July 1, 1965.
 - (35) The Effects of Touchdown Velocities on LEM Landing Capability, Memorandum for File, D. Macchia, September 3, 1965.
 - (36) The Effects of Initial Vehicle Attitudes, Attitude Rates and Landing Direction on Landing Stability of LEM Type Vehicles, Memorandum for File, D. Macchia, September 3, 1965.
 - (37) Vehicle Landing Characteristics on an Irregular Surface, Memorandum for File, J. A. Nutant, September 3, 1965.
 - (38) The Effects of Rocket Stabilization on a Structurally Performance Limited LEM, Memorandum for File, D. Macchia, September 3, 1965.
 - (39) An Evaluation of Bendix Computer Programs, Memorandum for File, G. W. Findley, September 2, 1965.

TASK ORDER NO. 21

STUDIES CONNECTED WITH SATURN IB/V LAUNCH VEHICLE COMPUTER-
CONTROLLED ESE SYSTEM

A. DISCRETE OUTPUT NETWORK STUDIES

Studies were completed on the use of triple redundant relay logic instead of semi-conductor logic for the discrete output network in the Saturn V Launch Control System. Two alternate designs were devised for relay networks both of which meet MSFC operational requirements and include features to guard against undetected failures and errors. A failure analysis indicates that both networks can achieve a reliability objective of 0.995. Final reports on these studies have been issued. (40) (41)

B. REVIEW OF DATA LINK TERMINALS AND MODEMS

The review of the Saturn IB/V data link terminals and modems has been completed and a final report was issued. (42)

(40) The Application of Relay Logic to the Saturn V Discrete Output System, TR-65-221-4, D. M. Duty, V. Muller, September 20, 1965.

(41) Failure Analysis of Discrete Output Networks for Saturn V ESE, TR-65-221-5, J. Kranton, September 20, 1965.

(42) Saturn IB/V Data Link Evaluation, TR-65-221-3, E. L. Gruman, July 14, 1965.

TASK ORDER NO. 22

MANAGEMENT PROCEDURES IN COMPUTER PROGRAMMING FOR APOLLO

Schedules and status of Apollo software are being monitored and monthly status summaries have been prepared.

A draft document on configuration management for computer programs was distributed to the Centers for comments. A presentation was made to the MSFC Automation Sub Board #4 at Downey, California, August 17, 1965, in which configuration management and other management control tools for computer software were discussed.

TASK ORDER NO. 24

MILA OPERATIONS AND EQUIPMENT REVIEW

A study of Launch Complex 39 activation milestones was completed. A memorandum was prepared closing this specific activity.

In support of systems configuration studies a continuous monitoring of activities of the Apollo Launch Operations Committee, KSC, and Saturn IB and Saturn V Site Activation Boards was undertaken.

Continued monitoring of Launch Complex Interface Control Documentation was conducted through participation in a review at KSC and follow through on a specific ICD covering the interface between the Apollo Access Arm and the Apollo Command Module.

Results of a study to determine the flexibility which could be planned in the Saturn V cryogenic loading schedules were published. (43)

(43) Saturn V Cryogenic Loading Schedules, TM-65-2032-2, G. W. Craft, September 1, 1965.

TASK ORDER NO. 25

MSF CENTER COMPUTER OPERATIONS STANDARDIZATION

The first phase of the task was completed with a presentation to the MSF ADP Resources Sharing Panel (RSP) on September 9, 1965 at MSF. (44) A draft report containing the following was distributed to the RSP members for comment: (a) a survey of ADP resources currently in use in the MSF Computation Laboratories and identifying those resources amenable to sharing; and (b) the general requirements of a system for sharing computer programs.

Recommendations were also made for the adoption of standard calibration formats for telemetry data and computer program documentation. At a meeting held at MSC on September 16, 1965, agreement was reached on a standard calibration format.

(44) Bellcomm Presentation to the ADP Resources Sharing Panel, Memorandum for File, B. H. Liebowitz, September 20, 1965.

TASK ORDER NO. 26

SATURN IB/CENTAUR SYSTEMS ENGINEERING

A principal activity has been the preparation of a draft Project Development Plan in conjunction with the Saturn IB/Centaur Program Director. The draft was circulated for comments.

A preliminary draft of the Saturn IB/Centaur Program Specification was delivered. Comments were delivered on a draft of the test plan which is closely associated with the specification.

A review of the program-wide system engineering activities and responsibilities was submitted. (45)

A draft system description is being prepared.

Mission analysis activity has included the preparation of: a preliminary flight mission assignment plan, (46) a mission sequence plan (47) and a study of flight wind criteria. (48)

In addition to the continuing work on the system description, studies are underway in the following areas: (a) applicability of the Saturn IB/Centaur to other planetary missions, (b) Voyager contamination and sterilization requirements, (c) planetary communication requirements, (d) Earth atmospheric dust characteristics, (e) Mars atmospheric braking characteristics, (f) launch tracking requirements, (g) Centaur/IU guidance functions and (h) the S-IVB cutoff sequence.

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- (45) Study of Technical Management for Saturn IB/Centaur Project, Memorandum for File, J. E. Volonte, August 25, 1965.
 - (46) Flight Mission Assignments for Saturn IB/Centaur Launch Vehicle, Memorandum for File, J. E. Volonte, September 29, 1965.
 - (47) Saturn IB/Centaur/Voyager Mission Analysis-Identification of Launch Vehicle Related Problem Areas and Voyager Mission Sequence of Events, Memorandum for File, P. H. Whipple, September 14, 1965.
 - (48) Flight Wind Loads for Saturn IB/Centaur/Voyager Program, Memorandum for File, P. L. Havenstein, September 24, 1965.

ENGINEERING SUPPORT

Computing Facility

The following is a list of major study areas for which programs were completed during this quarter:

- (1) Landing Dynamics
- (2) Energy Dissipation Characteristics of Landing Gear Configurations
- (3) Spacecraft Design Study
- (4) Lunar Slope Perception
- (5) Photographic Mission Interpretation
- (6) Orthographic Plotting
- (7) Program Storage and Retrieval

The applications programming staff assisted various Bellcomm groups in areas such as:

- (1) Targeting and Trajectory
- (2) Lunar Reconnaissance Trajectory Study
- (3) Guidance and Navigation System Performance Evaluation
- (4) General Purpose Data Storage and Retrieval System
- (5) Apollo Communications System Capability
- (6) Surveyor Approach and Descent - Vernier Descent
- (7) Meteoroid Mass/Velocity Distributions
- (8) Lunar Orbit Display
- (9) Lunar Landing Site Selection
- (10) Tracking Coverage Display
- (11) Terrain Analysis for LEM Guidance

ADMINISTRATIVE

CONTRACT AND FINANCIAL

During August and September negotiations with NASA concerning the statement of work, estimated cost and fixed fee, man-years, and related subjects were completed for the fourth contract period (October 1, 1965 through September 30, 1966). An amendment to the contract covering these matters was executed on October 7, 1965.

BELLCOMM REPORTS AND MEMORANDA

(Listed in Report Date Order)

This index includes technical reports and memoranda issued during this period covering particular technical studies.

The memoranda were intended for internal use. They represent the opinion of the authors at that time. Thus, they do not necessarily represent the considered judgment of Bellcomm which is reflected in the published Bellcomm Technical Reports.

<u>TITLE</u>	<u>DATE</u>
<u>A Plan for Validation and Verification of Apollo Flight Computer Software</u> , TR-65-209-6, J. S. Engel, W. G. Heffron, Unclassified	July 1, 1965
<u>LEM Descent Engine Jettisonable Skirt</u> , Memorandum for File, J. Wong, Unclassified	July 1, 1965
<u>Lunar Orbiter Data Analysis-Data Accuracy Goals</u> , TM-65-1012-5, C. J. Byrne, Unclassified	July 2, 1965
<u>Tape Recording of Lunar Orbiter Pictures</u> , TM-65-1012-6, C. J. Byrne, Unclassified	July 6, 1965
<u>Payload Capabilities of Saturn-IB Launch Vehicles with Boost Assisting UTC Solid Rocket Motors</u> , Memorandum for File, D. R. Valley, Unclassified	July 7, 1965
<u>Unified S-Band Tracking and Communications Coverage of the Manned Space Flight Network During Eighteen Earth Revolutions at 105 NM Altitude for Launch Azimuth at 72, 80, 90, 100, and 108 Degrees</u> , Memorandum for File, J. P. Maloy, Unclassified	July 9, 1965
<u>Saturn IB/V Data Link Evaluation</u> , TR-65-221-3, E. L. Gruman, Unclassified	July 14, 1965
<u>Apollo Lunar Data Analysis</u> , TM-65-1012-7, C. J. Byrne, Unclassified	July 19, 1965
<u>Modification of the H-1 Engine for Altitude Performance with the Saturn-IB Stage "O" Vehicle</u> , D. R. Valley, Unclassified, Memorandum for File	July 26, 1965

<u>TITLE</u>	<u>DATE</u>
<u>Presentation on "Communicating Total Data from Space Vehicles to MCC in Real Time", Memorandum for File, J. J. Hibbert, Unclassified</u>	July 27, 1965
<u>Surveyor TV Pictures by Earthlight, Memorandum for File, H. W. Radin, Unclassified</u>	July 29, 1965
<u>Mission Control Center - Houston; Acceptance Plan Review; Final Technical Report, TR-65-219-1, L. A. Ferrara, Unclassified</u>	July 30, 1965
<u>RCS Mixture Ratio and Propellant Changes (U), Memorandum for File, G. R. Huson, CONFIDENTIAL</u>	July 30, 1965
<u>Summary of Work Performed Under Bellcomm/NASA Task 15 Amendment 1 (April 1, 1965 - March 31, 1965), TR-65-215-2, J. J. Hibbert, A. G. Weygand, Unclassified</u>	July 30, 1965
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<u>Summary of the Electromagnetic Interference Control Activities of the MSFC, the KSC, and the MSC for the Apollo Program, TM-65-2021-7, A. G. Weygand, Unclassified</u>	August 9, 1965
<u>The Analysis of a Countdown as a Stochastic Sequential Process with Recycle Policies, TM-65-1031-2, J. S. Engel, Unclassified</u>	August 16, 1965
<u>Teflon Insulated Wire for Space Vehicle, Memorandum to M. Savage - NASA/MAT from J. Z. Menard, Unclassified</u>	August 17, 1965
<u>Apollo Extension Systems for Continuous Earth Orbital Missions (U), TM-65-1013-2, P. W. Conrad, CONFIDENTIAL</u>	August 18, 1965

<u>TITLE</u>	<u>DATE</u>
<u>A Procedure for Reducing the Time Required for the Digital Processing of Photographs</u> , TM-65-1012-4, M. A. Leibowitz, Unclassified	August 25, 1965
<u>Study of Technical Management for Saturn IB/Centaur Project</u> , Memorandum for File, J. E. Volonte, Unclassified	August 25, 1965
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<u>Response to Action Item "What are the Effects on LEM and SM Structure of Increasing RCS Engine Weight"</u> , Memorandum for File, J. J. O'Connor and V. Muller, Unclassified	August 27, 1965
<u>Astronaut Control of the Lunar Landing; I - Overview of Selected Studies</u> , Memorandum for File, S. J. Schoen, Unclassified	August 27, 1965
<u>Review of AS-201 and AS-501 Inter-Center Interface Control Documents</u> , W. T. Botner, J. D. Richey, C. M. Volk, and H. A. Wentz, Memorandum for File, Unclassified	August 30, 1965
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<u>The Effects of Descent Engine Nozzle Side Loads on LEM Landing Stability</u> , Memorandum for File, D. Macchia, Unclassified	September 3, 1965

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<u>The Effects of Touchdown Velocities on LEM Landing Capability, Memorandum for File, D. Macchia, Unclassified</u>	September 3, 1965
<u>The Effects of Initial Vehicle Attitudes, Attitude Rates and Landing Direction on Landing Stability of LEM Type Vehicles, Memorandum for File, D. Macchia, Unclassified</u>	September 3, 1965
<u>Vehicle Landing Characteristics on an Irregular Surface, Memorandum for File, J. A. Nutant, Unclassified</u>	September 3, 1965
<u>The Effects of Rocket Stabilization on a Structurally Performance Limited LEM, Memorandum for File, D. Macchia, Unclassified</u>	September 3, 1965
<u>Final Report Task 20 Amendment 1 Lunar Landing Systems Engineering Study, TR-65-220-3, D. Macchia, J. J. Tschirgi, Unclassified</u>	September 8, 1965
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<u>Saturn IB/Centaur/Voyager Mission Analysis-Identification of Launch Vehicle Related Problem Areas and Voyager Mission Sequence of Events, Memorandum for File, P. H. Whipple, Unclassified</u>	September 14, 1965
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<u>Failure Analysis of Discrete Output Networks for Saturn V ESE, TR-65-221-5, J. Kranton, Unclassified</u>	September 20, 1965
<u>Bellcomm Presentation to the ADP Resources Sharing Panel, Memorandum for File, B. H. Liebowitz, Unclassified</u>	September 20, 1965
<u>Flight Wind Loads for Saturn IB/Centaur/Voyager Program, Memorandum for File, P. L. Havenstien, Unclassified</u>	September 24, 1965

TITLE

DATE

Flight Mission Assignments for Saturn IB/Centaur Launch Vehicle, Memorandum for File, J. E. Volonte,
Unclassified

September 29, 1965

Proposed Improvement in Countdown Flexibility for the Apollo/Saturn V Lunar Landing Mission, Memorandum for File, C. H. Eley, Unclassified

September 30, 1965

Report on Excess Water Production of Fuel Cells on GT-5, Memorandum for file, F. N. Schmidt, Unclassified

September 30, 1965

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